Kenya mission report

22nd to 30th November 2009

Expertise and support at the Kenyan Sugar Research foundation (KESREF) in the framework of the establishment of a GIS and Remote sensing unit

Pierre TODOROFF
Decision support tools, GIS, Remote Sensing
Annual Crops Research Unit
CIRAD – Réunion

Special Thanks

I would like to thank Dr. George E. Okwach, KESREF Director, for his initiative and support in the organization of this mission and his wide vision of new technologies benefits.
Many thanks also to the CIRAD team in Nairobi, D. Depommier, CIRAD Regional Director, and his assistant Hilda Kegode who made this mission possible and offered valuable logistic support.
Many thanks to S. Muturi and Betty Mulianga for the perfect organization of this visit and taking care of me from early in the morning to sometimes late in the evening!
Thanks to the people we met at KESREF and external offices for sharing their time and knowledge with us.

Agenda

22th november evening	Arrival in Nairobi
23 th november	Flight to Kisumu Courtesy call at KESREF hdqs–Kibos on Dr Noah Wawire (Acting Director) Working session with B. Mulianga and S. Muturi Visit of future KESREF research compound *Lunch* Preparation of Tuesday's work programme
24 th november	Census of equipment needs Identification of GIS and RS needed softwares Modification of future GIS/RS unit offices' sketches Meeting with KESREF staff, presentation of the principles and potential applications of RS in agriculture *Lunch in Kisumu and short tour of the city* Adjusting and refining of the GIS unit equipments
25 th november	Planning data collection programme for B. Mulianga Visit to / meeting with Mumias Co officers
26 th november	Visit of KESREF Kibos weather station Refining of the GIS/RS unit equipments list *Lunch* Flight to Nairobi
27 th november	Visits -Regional Centre for Mapping of Resources for Developments -KSB -KARI GIS lab at the National Agricultural Research Laboratories Centre
28 th november	Day off. Visit of Nairobi National Park (B. Mulianga) Mission report redaction
29 th november	14h: final meeting with the Director (+S. Muturi and B. Mulianga) Return flight to Reunion

People met

KESREF

Dr. George E. Okwach	Director
Dr. Noah Wawire	Head -Economics and Biometrics
Stephene Muturi	Head - Agricultural Engineering
Peter Maina	Assistant research scientist -Biometrics
James O.Odenya	Head - Technology transfer
Lillian Nyaluogo	Human resource manager
Barrack O. Otieno	Assistant research scientist
Aloys N. Nyang'au	Research Assistant
Caroline Agosa	Assistant Research scientist- Agro meteorology
Betty Mulianga	Research scientist - GIS

MUMIAS SUGAR COMPANY

Mr. Maurice P. Lukano	Agricultural Training and Extension Manager
Mr. William Kalande	GIS Manager

REGIONAL CENTRE FOR MAPPING OF RESOURCES FOR DEVELOPMENTS (RCMRD)

Byron A. Okubasu Anangwe	Product Development Executive

KENYA SUGAR BOARD (KSB)

Francis Ingara	Head – Sugar Technology & Engineering Dpt, Acting Director

KARI

P.T. Gicheru	National Agricultural Research Labs Director

Maurice P. Lukano
Training & Extension Manager

MUMIAS SUGAR COMPANY LIMITED

MUMIAS SUGAR COMPANY LIMITED

Head Office
P.O: Private Bag Mumias, Kenya
Tel: +254 56 641620/1
Fax: +254 56 641234
Cell: +254 722 203891-5, 0734 600334/5
email: msc@mumias-sugar.com

Nairobi Office
P.O. Box: 57092 cty sqr 00200 Nairobi, Kenya
Tel: +254 20 271 2317/8
Fax: +254 20 271 2316
Cell: 0720 140080, 0734 600296

email: mlukano@mumias-sugar.com
cell: 0734 601 500

0722774916.

REGIONAL CENTRE FOR MAPPING OF RESOURCES FOR DEVELOPMENT (RCMRD)
Kasarani Road
P. O. Box 632-00618 Ruaraka, Nairobi, KENYA

Byron A. Okubasu Anangwe
Product Development Executive

Tel: +254-20-8560227/65
Fax: +254-20-8561673/3767
Cell Phone: +254-722-357528/735-981098
E-mail: banangwe@rcmrd.org, byron.anangwe@yahoo.co.uk

More Sugar for Prosperity
KSB

Francis Ingara
Head of Sugar Technology
& Engineering Department

Kenya Sugar Board
Sukari Plaza,Off Waiyaki Way
P.O. Box 51500-00200, Nairobi
Tel: (254-20) 2023316/7/8/9
Tel: (254-20) 2700572/3/4/5
Mobile: +254-722-203128/7,
+254-733-333378/9
Fax: (254-20) 2021266/77
email: fingara@kenyasugar.co.ke

KARI

P.T. Gicheru
(PhD)
SOIL SCIENTIST

Director
National Agricultural Research Labs

P.O. Box 14733-00800, Waiyaki Way Nairobi, Kenya
Tel: +254-20-4443926, Fax: +254-20-4443926
Mobile: 0722-465642
Email: cdnarl@iconnect.co.ke

Context

The Kenyan sugarcane industry is facing severe difficulties due to: low productivity of both sugarcane and milled sugar and high production costs. There is a general agreement at national level that there is considerable potential improvement of this situation, thanks to science and technology support.

In the late 1980, the re-organisation of the Kenya Agricultural Research Institute (KARI) paved the way to the creation of the Kenya Sugar Research Foundation (KESREF) in 2001 with mandate to develop and introduce cutting-edge technologies on sugar production processes, from the field to the market.

In this framework, KESREF decided to establish a GIS and Remote Sensing unit in its headquarters in Kibos to increase the institution's capacity to serve the sugar industry. A GIS/RS expert was recruited in November 2009 by name Mrs Betty Mulianga.

Besides, there is an on-going collaborative agreement between KESREF and CIRAD, expressed by a letter of intent and actualized by a memorandum of understanding. Remote sensing data processing and GIS tools fall among the identified fields of collaboration.

In this framework, on the demand of KESREF and as a first collaboration stage, it was decided that I would visit KESREF so as to:

- review the structure and layout of the Kenyan sugar industry so as to understand the technological needs that can be addressed with GIS/RS to manage the sugarcane production in the country.
- Design and propose appropriate GIS/RS installations for managing Kenya's sugarcane crop and growing areas with GIS/RS.
- Propose appropriate hardware and software needed by KESREF.
- Recommend future improvements and training needs for KESREF staff who will be engaged in a day-to-day use of this technology.

GIS / Remote Sensing Unit installations and equipments

A comprehensive list of the suggested equipments is presented in the annex.

1 - Installations

KESREF headquarters are located in Kibos, close to Lake Victoria, within the Nyando sugar belt. The KIBOS station also hosts the research laboratories. A situational analysis exposed in its strategic plan 2005-2010 has highlighted the serious inadequacy of KESREF physical infrastructure to fulfil its mandate. These strategic issues have now been overcome, thanks to government funds to build modern and adequate offices and laboratories.

The construction of a large research complex is ongoing in Kibos centre on an area of more than 5 times the area of the current buildings. The delivery is expected at the beginning of year 2010. In this complex, a set of offices have been identified to host the GIS/RS unit. It was formally located in the workshops building, at the rear end of the compound. A number of modifications would have to be done to secure and adapt the offices for computer based activities.

As new technology implementation and transfer is the essence, the constitutive watchword of KESREF, and as GIS/RS is a potentially strategic information tool for all the research activities, we have suggested that the GIS unit should be located in a more central and visible place in the new compound, so as to become the spearhead of KESREF and be considered as a showroom. Together with B. Mulianga and S. Muturi we have studied several alternative options. One of these options, located in the previously labelled “milling laboratory” would ideally suit the needs of the unit.

Specific requirements

- an office for the GIS expert (B. Mulianga) plus an assistant
- a project room/lab intended for training purposes and hosting of students and participants from different organizations throughout the country or from foreign countries to work on specific/cooperation projects.
- Some hardware equipments (server, GPS reference station) should be located in a server room (already identified for IT purposes, nearby the future GIS unit lab and office).
- The rooms should be air conditioned so as to save the costly computer workstations and printing devices.
- A single UPS unit should be installed to secure the power supply of the computers in the lab and the office with specific cabling to foresee.

S. Muturi has to check for the feasibility of this option with KESREF staff and is expected to attend the forthcoming construction meetings so as to integrate these modifications in the ongoing building process.

2 - Hardware

To ensure the widest use of GIS into KESREF’s research activities and scientific culture it is proposed that about 6 scientists be equipped with adapted workstations (22” LCD monitors). The training activities should also rely on dedicated workstations.
A maximum number of 6 places seems to be sufficient as a first stage. Two more workstations are intended for the GIS expert and an assistant.

A GIS needs to be fed by georeferenced data. Remote Sensing images need georeferenced control points and ground truthing to be processed. Moreover, a lot of information, from

samples to specific measurements and observations, taken from the field by KESREF staff is not yet geo-referenced. It is as a consequence not usable in GIS analysis. To stop this waste of energy and data, the GIS unit would have to develop a “GPS culture” and make GPS measurements become a reflex in data acquisition at KESREF.

In this objective it is planned to equip the departments with at least 6 handheld GPS units to be distributed according to the activities of the teams. The GIS unit should also be equipped with a differential GPS (DGPS) for specific measurements that need accurate positioning. This accuracy is achieved via differential corrections made, thanks to the data recorded by a GPS reference station that should be installed near the GIS lab.

A GIS requires good visibility from inside KESREF, and also from stakeholders and other institutions, so as to be accepted, enriched and widely used. Printing hardcopy outputs and dissemination of the same is a very powerful way to answer this question. A large printer format (A0 plotter) and a laser printer are proposed.

The amount of data making up the GIS and RS database may become soon very large. It is proposed to have a dedicated computer with large (1 Tbytes) and secured (mirrored drives) hard drive capacity to act as a file sharing and backup server. The computers of the GIS team (server, GPS reference station, 8 workstations) should be powered by a UPS unit.

3 - Softwares

3.1 - Remote Sensing

Remote Sensing is a highly specialized technical domain that requires strong data processing expertise. It is not recommended that KESREF scientists invest themselves in these techniques. The GIS unit would be in charge of such processing and supply the scientists with ready to use data integrated into the GIS database.

The unit needs to be equipped with 2 licences of Erdas Imagine, one of the most widely used RS software: 1 standard licence for the GIS assistant or a project participant, and 1 advanced licence for the GIS expert.

3.2 – Geographic Information System

As far as GIS is concerned, discussions with B. Mulianga and the different organizations we have visited have converged to the following findings:

- the GIS software to be used by the scientists and the trainees must be easy to use
- this GIS software must be cheap and distributable to KESREF partners
- the GIS expert is the only one that needs a sophisticated GIS managing tool.

This led us to propose

- ArcGIS with an ArcInfo level licence for the GIS expert
- 2 licences of MapInfo, a medium level and widely used GIS software for the assistant and project participants and for import/export purposes with many existing data sources and users.
- the QuantumGIS freeware for the scientists, the trainees and project activities.

Construction of the database

As admitted by KESREF, the GIS unit would have to start from the scratch. The first step has just been realised with the recruitment of Mrs. B. Mulianga, a highly skilled person that is in charge of the GIS/RS activities at KESREF.

In parallel to the acquisition of equipment phase, one of the major objectives is the construction of the database.

We may identify 2 stages in data collection:
1 - basic dataset
2 - derived thematic datasets (climatic zonation, crop suitability areas, slopes,...)

The agenda of the unit in the forthcoming months will be heavily filled with performance of several activities concurrently. The team should then focus mainly on the basic dataset collection.
We have identified the following key data types:

- administration boundaries (international, provincial, districts, division, location, sub-location, municipal, National parks)
- roads and other infrastructures
- water resources (rivers, boreholes)
- forests
- land cover/land use
- soil
- irrigated areas
- sugar factories / transloading centers
- weather stations
- KESREF offices, demonstrations sites
- Sugarcane fields
- DEM

These data may have to be collected and georeferenced first before being added to the database. Some data are readily available in organizations for free (ex. KARI) or at a low cost via a Memorandum of Understanding (ex: RCMRD).

The RS data might be more difficult to access. As a matter a fact the images generally come with an end-user licence that defines the possible uses. The sharing of the images already acquired by another institution will then depend on the agreements between KESREF and the institution AND the licence rights. However, some RS images are freely downloadable on the Internet.
Nevertheless, thanks to its research capacity in GIS/RS in the near future, KESREF should access commercial RS data through cooperation projects that include RS processings.

Mrs B. Mulianga must complete the information gathered during this mission to have a more precise visibility on these data.

Training

Mrs B. Mulianga is highly skilled in GIS technique as well as Remote Sensing data processing. It doesn't seem necessary that she completes her knowledge by some more training, at least in the construction stage of the GIS/RS unit; except for the use and processing of differential GPS measurements.

In the opposite, KESREF staff seems to be inexperienced in GIS techniques.
Mrs Mulianga is perfectly able to conduct training for the scientists and field assistants in software use and GPS measurements. We took the option of working with QGIS with KESREF staff and trainees. Mrs. Mulianga will have to get familiar with this software and validate its suitability. As for most open source softwares, pedagogical materials must be available on Internet. A general introduction to GIS principles and applications given by professional training persons might however be useful for KESREF staff before moving on specific software use undertaken by Mrs. Mulianga.

Concerning GIS and RS application to sugarcane production survey and support, CIRAD has done a lot of works through different projects. The resulting tools are already available and may be transferred to KESREF as soon as it is equipped with GIS and RS facilities. We may consider a mission of Mrs Mulianga to Reunion Island with CIRAD sugarcane GIS unit in the following year.

Visits

Due to the limited period of this mission we have visited a few number of stakeholders and organizations with which KERSREF might establish partnership to share part of the data layers and develop GIS applications. These visits would have to be completed by Mrs. B. Mulianga so as to have a comprehensive overview of the available data and build an efficient strategy to collect and share these data.

1 - Mumias Sugar Company
The company has been establishing a GIS since 2006. But it is mainly used as a survey tool. It is currently composed of

- roads for logistics and maintenance purposes.
- Parcels data : national ID, name of the farmer, bank account, variety,...stored in a database. The boundaries have only been surveyed for 60% of the outgrowers fields.
- Topographic data on the nucleus
- Soil analysis (geo-referenced)
- Amenities (hospital, schools, bridges,...)

The GIS manager is working with ArcGIS (ArcInfo level licence) but the rest of the staff is using MapInfo for friendliness and ease of use reasons.

The main issues they are willing to address with GIS tools are:

- inaccuracy of cadastral maps (in terms of boundaries but also ownership which is rapidly changing)
- land tenure information access
- climate change
- food security

We had a warm reception from the training and extension manager as well as from the GIS manager. They were very happy that KESREF has decided to develop a GIS facility and are hoping for a very fruitful win-win collaboration.

2 - Regional Centre for Mapping of Resources for Developments
The Centre is an intergovernmental organization of 15 (soon 18) contracting members in Eastern, Central and Southern Africa. Kenya is one of the major subscribers. But at the same time that it is one of the country that benefits the least from the Regional Centre products, especially in the agricultural sector.

The product Development Executive was very excited that KESREF is going to be a new partner in GIS for Kenya's agriculture. He welcomed this initiative and is widely open to collaboration in data sharing, training and applications. The Regional Centre has a number of data that should interest KESREF and special contracts with satellite imagery providers that could benefit KESREF. He suggested that a Memorandum of Understanding be defined between the 2 institutions so as to ease the collaboration and data exchanges.

3 - Kenya Agricultural Research Institute
They have developed a GIS since 1991. They have many data and derived products as well as many partners in this field (Meteorological Dpt, ICRAF,...)

Since KESREF and KARI are sister governmental organizations, working with the same objective, the Director of NARLS considered that there must not be any barrier in

collaborating and sharing the data. This must however be formalized by a request letter from the KESREF Director to the KARI Director.

Their main data are made of:

- soil / terrain database (soil types and soil analysis)
- agro ecological maps
- climatic database (regularly updated from FAO data coming from the Met Office weather stations), but not georeferenced
- agroclimatic maps
- crop suitability maps

Recommendations

Agriculture is by nature a geographical activity driven by many factors of different nature at different scales. It is faced by issues involving more and more severe constraints, making the production process a highly complex problem to solve.
GIS and RS tools have been developed for managing and analyzing multidimensional spatial data of different types. They are today a must for anyone who wants to address the agriculture challenges.

KESREF is new in the domain of GIS and RS. The unit shall then start from the basics. But it has the chance of being viewed very favourably by the KSB board and the direction of KESREF which have already allocated a comfortable budget for its birth and first steps in the agricultural research world. This is a unique and exciting opportunity but nevertheless a difficult and demanding task.
Mrs Mulianga will have to be very active in different axis at the same time:

- Development of the GIS culture within KESREF and sugarcane industry.
She will have to pay much attention to the needs and difficulties of GIS users at KESREF.
This implies saving some time to visit regularly the different users, and organize information meetings/workshop to present results or application examples. It will also be necessary to develop and apply efficient communication techniques to make the unit's knowledge visible and attractive from both the inside and the outside. But GIS tools are very powerful in this domain too and will help her a lot.

- Construction of the GIS database and facilities.
A lot of her time will have to be dedicated to the data collection and the GIS database design.
She will have to develop her own network of stakeholders, partners, data and hardware suppliers. But I am very confident about her social relationship abilities to achieve this objective.

A special recommendation for weather data: a climatic database is key in agriculture and especially when one has the ambition to address geographically distributed characteristics as GIS can do. The building of a climatic database is crucial and should be paid much attention to, especially concerning the periodic collection of data (to avoid data gaps), quality, density and georeferencing of the stations network.

ANNEX

GIS/RS TEAM EQUIPMENT BUDGET ESTIMATION

Nb of assistants	Nb of trainees	Nb of Scientists
1	6	6

ITEMS	Quantity	Unit price (KSH)	Total price	Example
GPS				
DGPS	1	500 000	500 000	Trimble Geo XM + PathFinder Office
basic GPS	5	167 000	835 000	With data upload and download capacities
GPS reference station	1	500 000	500 000	
SUB TOTAL			**1 835 000**	
Computers				
Server	1	160 000	160 000	Dell Optiplex 960for file sharing. Secured/mirror hard drives - 1TB
Basic desktop	1	60 000	60 000	Dell Vostro 220 - for running the GPS reference station
GIS Workstation	13	90 000	1 170 000	Dell OPTIPLEX 960
Advanced GIS/RS workstation	1	130 000	130 000	Dell OPTIPLEX 960
Laptop	1	250 000	250 000	Dell Latitude XT2 or Latitude
SUB TOTAL			**1 770 000**	
Complementary hardware				
Laser color printer	1	50 000	50 000	hp Color LaserJet CP2025dn
Inkjet A3 printer	1	40 000	40 000	HP Officejet Pro K8600dn
Inkjet large printer (A0)	1	470 000	470 000	HP Designjet T770
Scanner A4	1	50 000	50 000	HP Scanjet 8300
Videoprojector	1	700 000	700 000	Sony VPLTX7
Digital camera	1	20 000	20 000	Fujifilm S1500
UPS	1	220 000	220 000	capacity for 10 workstations
Air conditionner	1	250 000	250 000	GIS exp. + Trainees room
SUB TOTAL			**1 800 000**	
Softwares				
Office 2007	8	40 000	320 000	
Mapinfo	2	280 000	560 000	
ArcGIS / Arcview	2	250 000	500 000	
ArcGIS / Arcinfo	1	2 220 000	2 220 000	
Q GIS	12	0	0	
Erdas Imagine / Advantage	1	800 000	800 000	
Erdas Imagine / Essentials	1	600 000	600 000	
SUB TOTAL			**5 000 000**	
Furnitures				
Operator desk	6	50 000	300 000	ex: 120° angle, no drawers
Manager desk	2	30 000	60 000	ex: 90° angle
Drawers	2	23 000	46 000	
Small desk	1	20 000	20 000	for trainees room (for printer,
High cabinets	2	45 000	90 000	metal, sliding doors/curtains
Low cabinet	2	30 000	60 000	metal, sliding doors/curtains
Book racks	1	100 000	100 000	
Armchair (GIS unit)	8	8 800	70 400	
Visitor chair	3	6 000	18 000	
SUB TOTAL			**764 400**	
Training	days			
GPS	3	300 000	300 000	+ installation of the GPS reference station
GIS	5	300 000	300 000	Introduction to GIS and initiation to ArcGIS
Sugarcane production support tools	7	150 000	150 000	Flight+accomodation CIRAD / Reunion Island
SUB TOTAL			**750 000**	
Imagery				
Satellite images				depending on the remaining
SUB TOTAL				
TOTAL without VAT			**11 919 400**	
VAT 16%			1 907 104	
TOTAL			**13 826 504**	